near the freezing point in the middle and southern sections. At 3 p. m. of the 12th the storm was central near Omaha, Nebr., from which position it moved to the northeast and passed to the north of the region of observation after 3 p. m. of the 13th. As the storm advanced, with rising temperature and south to east winds in the eastern quadrants, the wind suddenly shifted to the northwest and blew with increased velocity in the western quadrants, while the temperature in the rear of the storm suddenly fell from 30° to 50°, which intensely cold wave accompanied an area of high pressure then advancing from the northwest.

VI.—This disturbance was observed moving from the north Pacific eastward, and was central over Washington Territory on the morning of the 12th. It moved to the southeast till central over Colorado, then to the south, and was last observed in southern New Mexico on the 14th. It was attended by light rains in the north Pacific region on the 12th and 13th.

VII.—This low pressure area apparently developed in the Ohio Valley on the morning of the 17th. The central pressure was bounded by an isobar of 30.4. It moved to the northeast with decreasing pressure until north of Lake Ontario, then to the southeast, passing off the coast of Massachusetts on the morning of the 18th, with lowest pressure, 29.64, at Block Island, R. I. Precipitation was general throughout the Ohio Valley, the Lake region, the middle Atlantic and New England states during the passage of this low area.

VIII.—This storm apparently advanced from the Pacific Ocean to the coast of Washington Territory, where it was central on the morning of the 23d. It moved across the continent in a direction slightly to the south of east until it reached the Atlantic Ocean, after which it traveled to the northeast along the coast of New England and passed beyond the Maritime Provinces on the morning of the 27th. It was attended by light rains on the Pacific coast during the 23d, and by a decidedly warm wave over the northern and middle slopes of the Rocky Mountains and the Missouri Valley on the 24th, during which the rise in temperature was from 30° to 50° in twenty-four hours, with fair weather in all regions covered by the area on that date. On the morning of the 25th the storm was central over the Lakes, when light snow had set in, which during the day became general over the Ohio Valley, middle Atlantic, and New England states. The pressure at the centre began to decline rapidly, and when last observed it was 28.58 at Chatham, N. B. Violent gales prevailed on the middle Atlantic and New England coasts from midnight of the 25th till the morning of the 28th, the maximum velocity in many cases reaching sixty miles per hour.

IX.—This area of low pressure was first observed central over Washington Territory at 3 p. m. of the 25th. It moved in a direction slightly to the north of east, then to the southeast, and disappeared over Iowa, Illinois, and Missouri after 10 p. m. of the 26th, by a gradual increase of pressure. It was attended by fair weather and high temperatures, excepting on the north Pacific coast, where rains occurred.

X.—The approach of this low area was indicated by low readings of barometers over Manitoba, beginning on the morning of the 27th. The centre was first located to the north of Dakota at midnight of the 29th. It moved to the southeast with increasing pressure, attended by light winds and fair weather, passing to the ocean from the coasts of Virginia and North Carolina on the morning of the 31st.

NORTH ATLANTIC STORMS FOR JANUARY, 1888.

[*Pressure in inches and millimetres; wind-force by Beaufort scale.*]

The paths of the depressions that appeared over the north Atlantic Ocean during January, 1888, have been determined from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the co-operation of the the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Nine depression are traced, of which six advanced eastward from the American continent north of the fortieth parallel; one developed over mid-ocean between the fortieth and forty-fifth parallels and moved east-northeast to the British Isles; one is given an approximated path from the vicinity of the Azores southwestward to the thirty-ninth meridian, and thence northward, and one passed south of east over the British Isles from the vicinity of the sixtieth parallel. With the exception of numbers 3, 6, and 7, the depressions pursued normal paths.

In January, 1887, twelve depressions were traced, of which seven passed northeastward over or near Newfoundland; four first appeared over mid-ocean, and one developed off the east coast of the United States. The depressions pursued east-northeast to northeast paths, and, being rather evenly distributed throughout the month, with tracks, as a rule, confined to territory north of the fiftieth parallel, caused a continuation of strong westerly gales in the trans-Atlantic routes.

In January, 1888, the depressions traced corresponded closely in number with the January average, and their passage was unattended by disturbances of unseasonable severity. The region of greatest storm frequency extended east-northeast from Newfoundland, and all depressions traced from the American coast disappeared to the northward of the region of observation between the twentieth and fortieth meridians. Two well-defined depressions advanced from the ocean over the British Isles, and two developed west of the Azores.

The month opened with an area of low pressure central northwest of Ireland, and moderate to fresh gales along the trans-Atlantic tracks to the Grand Banks. To the southward of Nova Scotia barometric maxima rising to about 30.50 (774.7) were shown. During the 2d cyclonic disturbances continued over the British Isles, and unsettled weather and fresh to strong gales prevailed east of the fiftieth meridian. On the 3d two storms of marked energy, one of which had moved northeast over mid-ocean, and the other had advanced east over Newfoundland, dominated the weather conditions from coast to coast. By the 4th the barometric pressure had risen off the coasts of the United States, following the eastward movement of the depression central on the 3d off the Newfoundland coast. During the remainder of the first decade of the month there was a gradual increase in pressure over the British Isles, with fresh and brisk south to west winds; over mid-ocean barometric minima falling below 29.00 (736.6) attended the presence during the 5th and 6th of an area of low pressure central north of the fiftieth parallel; and from the 8th to the 10th, inclusive, storms of great violence were occasioned by a depression which moved northeast from Nova Scotia. During the second decade the barometer continued uniformly high over the British Isles. From the 15th to the 18th, inclusive, stormy weather prevailed west of the Azores, attending the presence in that region of a depression of considerable energy. The second decade was marked by the passage over Newfoundland and the western portion of the ocean of two depressions of great strength. During the last eleven days of the month no important disturbances occurred over the British Isles until the 31st, when the presence of a depression over the North Sea was indicated. Over mid-ocean moderate to fresh gales prevailed until the 26th, after which the pressure continued high with generally settled, fair weather. Over the western portion of the ocean stormy weather prevailed during the third decade, attending the passage of three depressions, two of which are traced over Newfoundland as ocean storms, and one, which advanced along the New England coast and over the Canadian Maritime Provinces during the 26th and 27th, is described under the heading "Areas of low pressure."

In the following descriptions of the depressions traced, posi-

tions are given in degrees latitude and longitude, except in cases where twenty-five to thirty-five minutes are cited, when they are shown in degrees and half degrees:

1.—This depression was central on the 1st between Iceland and Ireland, with central pressure below 29.00 (736.6); by the 2d it had apparently advanced to the vicinity of the Hebrides Islands, with fresh north to west gales to the thirtieth meridian; by the 4th the storm-centre had disappeared beyond the region of observation.

2.—This depression was central on the 1st in about N. 44°, W. 37°, with fresh to strong gales between the thirtieth and sixtieth meridians; by the 2d the storm-centre had moved slowly north of east to the forty-fifth parallel, with pressure falling to about 29.50 (749.3), whence it passed northeast to N. 52°, W. 25° by the 3d, with central pressure about 29.20 (741.7). By the 4th the centre of depression had advanced to the vicinity of Ireland, where values below 29.30 (744.2) were shown; after which it pursued a northerly path over the British Isles, and disappeared in the direction of the Norwegian coast after the 5th.

3.—This depression moved eastward from the Gulf of Saint Lawrence, and on the morning of the 3d was central off the northeast coast of Newfoundland, with pressure below 29.20 (741.7). By the 4th the storm-centre had advanced north of east to the forty-second meridian, with a marked decrease in barometric pressure, and by the 5th had passed northeast to about N. 55°, W. 38°, where central pressure below 29.00 (736.6) was shown. During the next twenty-four hours the depression recurved slightly to the southwestward without evidence of loss of energy, after which it moved eastward to the thirtieth meridian and disappeared north of the region of observation after the 7th. On the night of the 2d, a strong southerly gale, accompanied by snow and heavy rain, was reported by Mr. John Higgins, observer at Saint John's, N. F. The gale continued until 10 a. m. of the 3d, when it veered to northwest.

4.—This depression was central on the 8th south of Newfoundland, in N. 45°, whence it had advanced from the westward. By the 9th it had moved rapidly northeast to about N. 52°, W. 40°, with pressure below 29.00 (736.6), from which position it passed slowly northeast about three degrees by the 10th. At 12 noon, Greenwich time, of the 11th the storm was central in about N. 57°, W. 27°, and by the 12th had disappeared in the direction of Iceland.

5.—This depression passed eastward over the northern extremity of Newfoundland during the 11th, with central pressure below 29.40 (746.7), and by the 12th had advanced north of east to the forty-fifth meridian, after which it pursued an east-northeast track and disappeared north of the fifty-fifth parallel, attended throughout by strong gales.

6.—The presence of this depression southwest and west-southwest of the Azores was shown by reports of the 14th, 15th, 16th, and 17th, during which period fresh to strong gales and falling barometer prevailed in that region, with high barometric pressure to the east and northeast of the Azores. By the 18th the depression had moved northward to the forty-fifth parallel, attended by strong to whole gales, and minimum pressure about 29.20 (741.7), after which it apparently recurved westward under the influence of depression number 7, which had moved eastward from the middle Atlantic coast states.

7.—This depression was central on the 18th southwest of Nova Scotia, in about N. 41°, without evidence of marked energy, whence it advanced to the south of Newfoundland, in N. 44°, by the 19th, in which position barometric minima falling below 28.90 (734.0) were reported. By the 20th the depression had moved northward over Newfoundland, with an apparent increase in pressure, and by the 21st was central off the northeast coast of Newfoundland. During the next three days the centre of depression moved east-northeast, with a moderate display of energy, and subsequent to the 24th disappeared in the direction of Iceland.

8.—This depression moved eastward from Nova Scotia during the 24th, and by the 25th had advanced to the eastward of Newfoundland, with pressure below 29.00 (736.6) and strong to whole gales. By the 26th the depression had moved northeast to the fortieth meridian, with a marked increase in central pressure, after which it disappeared north of the region of observation. Mr. John Higgins, observer at Saint John's, N. F., reports: "24, southeast gale sprang up 7 p. m., accompanied by snow; continued quite violent until 11 p. m., when sleet fell, changing into rain; barometer fell from 30.11 (764.8) in the morning to 28.94 (735.1) during the night; wind veered to northward and increased in force on the morning of the 25th."

9.—This depression was the continuation of an area of low pressure of great energy that passed along the New England coast during the 26th and advanced over the west portion of the Gulf of Saint Lawrence by the morning of the 27th. During the 28th the depression moved to the northward of Newfoundland beyond the region of observation.

OCEAN ICE.

On chart i the positions of icebergs reported during the month are shown by ruled shading. On the 31st the s. s. "Maine" passed two bergs, one very large, in N. 45° 20′, W. 50° 01′, and an ice bank was observed to the northward. In January, 1887, a medium sized berg was observed in N. 48° 30′, W. 46° 00′, on the 30th. In January, 1886, several icebergs were observed off the southeast coast of Newfoundland. In January, 1885, icebergs were reported between W. 45° 30′ and W. 42° 24′, none being observed south of the forty-seventh parallel. In this month they were observed eleven days earlier and were about four degrees farther eastward than those of January, 1884. In January, 1883, the first icebergs reported were observed in N. 47° 35′, W. 45° 04′ on the 30th, and in the corresponding month of 1882 the first icebergs were seen in N. 47° 30′, W. 48° 35′ on the 30th.

From the above it will be seen that while the quantity of ice observed during January, 1888, corresponded closely with the January average for the preceding six years, its position was nearly two degrees farther south and somewhat to the westward of the usual January ice limits. In but one other year, 1886, was ice reported as far west as the fiftieth meridian, and in 1886 and 1888, only, was it observed south of the forty-seventh parallel.

FOG.

The following are the limits of fog-areas on the north Atlantic Ocean during January, 1888, as reported by shipmasters:

Date.	Vessel.	Entered.			Cleared.		
		Lat. N.	Lon. W.	Time.	Lat. N.	Lon. W.	Time.
		° ′	° ′		° ′	° ′	
2	S. S. Iowa	43 00	63 57	Noon	42 32	66 39	11 p. m.
12	S. S. Philadelphia	36 41	72 27	.....	36 19	72 15	
13	S. S. New York	35 34	75 11	10 p. m.	35 15	75 13	Midnight.
14	S. S. Hibernian	Off Cape May..		4 a. m. to 5 p. m.			
15	S. S. Carondelet	35 20	75 10	.....	36 56	74 55	
15–16	S. S. DeRuyter	49 57	37 18	9 a. m.	47 24	44 53	8 p. m.
15–16	S. S. Umbria	40 47	68 34	5.30 p. m.	40 30	70 51	2 a. m.
16	S. S. Galileo	44 10	46 50	3 p. m.	44 08	47 48	7 p. m.
17–18	S. S. Italy	45 40	48 30	.....	45 50	47 20	
18	S. S. Concordia	45 10	47 43	6.30 a. m.	45 18	47 23	11 a. m.
18	S. S. Ems	45 08	47 00	10 a. m.	45 00	49 07	5 p. m.
19	S. S. Servia	45 08	45 19	6.30 a. m.	44 54	46 11	8.30 a. m.
19	S. S. Devonia	47 36	45 25	.....	46 25	48 00	
19	S. S. Palestine	48 35	43 24	8 a. m.	48 13	42 51	Noon.
19	S. S. Oregon	49 30	46 40	8 a. m.	49 22	47 50	2 p. m.
24	S. S. Australia	41 18	64 06	.....	41 08	66 23	
27	S. S. Lord Clive	44 10	51 30	Noon	43 56	52 40	8 p. m.
27	S. S. Surrey	44 55	49 15	.....	44 45	49 50	
27–28	S. S. Gallia	44 04	47 06	11.10 p. m.	43 28	50 20	9.20 a. m.
27–29	S. S. Tower Hill	45 50	46 00	.....	44 30	52 50	
28	Fog at Cape Race						
28	S. S. Surrey	44 06	54 32	.....	44 05	54 45	
28	S. S. Mineola	46 30	43 40	8 p. m.	45 10	48 49	10.50 p. m.
28–29	S. S. Siberian	45 00	44 30	4 p. m.	43 30	50 10	1 p. m.
28–29	S. S. Bohemia	45 07	46 00	5.05 a. m.	43 48	53 35	2.05 p. m.
29	S. S. Belgenland	45 48	46 24	11.30 a. m.	44 05	49 15	11.15 p. m.
29	Fog at Cape Race						
31	S. S. Cephalonia	44 47	47 32	8 a. m.	43 50	48 10	Midnight.
31 Feb. 1	S. S. Republic	46 06	47 20	.....	45 09	50 50	

The limits of fog-belts to the westward of the fortieth meridian are shown on chart i by dotted shading.

As compared with the chart of the preceding month, December, 1887, the eastern limit of the Newfoundland fog-belt has extended about five degrees, and the southern limit remains about the same. No isolated fog-area appears off the southeast edge of the Banks, however, as in December. To the southward of Nova Scotia fog was observed nearly three degrees farther south than in the preceding month, and on a corresponding number of dates, while along the coast of the United States fog-areas were encountered about three degrees farther south than during December.

On the dates for which fog was reported near Newfoundland the meteorological conditions were as follows: Although no fog was reported in this region until the 15th instant, the atmospheric conditions were apparently favorable for its precipitation on the 3d, 8th, and 11th. On the first mentioned date a barometric depression passed eastward north of the Banks, and the non-development of fog was probably due to unusual influences exerted by an area of low pressure which moved northeastward east of the Banks during the first three days of the month, causing northwesterly winds over the fog-region until the immediate presence of the depression which advanced from the westward. On the 7th and 8th similar conditions prevailed. On the 11th the conditions were favorable for fog, although none has been reported. During the 15th, 16th, and 17th fog was encountered off the eastern edge of the Banks, with easterly winds attending the presence to the southward of an area of low pressure. During the 18th and 19th the passage of a barometric depression from the middle Atlantic coast to Newfoundland caused south to southeast winds and fog over the Banks. On the 24th the conditions were favorable for fog, but none has been reported. During the 27th, 28th, and 29th the presence of a depression over the Gulf of Saint Lawrence caused southerly winds and fog, and on the 31st south to southeast winds and fog were reported off the eastern edge of the Banks. On the two dates, the 2d and the 24th, for which fog was reported south of Nova Scotia, the barometric pressure was low and southerly winds prevailed, attending the presence over Nova Scotia or New Brunswick of areas of low pressure. For the five dates, from the 12th to 16th, inclusive, on which fog was reported off the coast of the United States, the winds were variable or anti-cyclonic, and the barometric pressure abnormally high.

TEMPERATURE OF THE AIR (expressed in degrees, Fahrenheit).

The distribution of mean temperature over the United States and Canada for January, 1888, is exhibited on chart ii by dotted isothermal lines. In the table of miscellaneous data are given the monthly mean temperatures, with the departures from the normal, for the various stations of the Signal Service. The figures opposite the names of the geographical districts in the columns for mean temperature, precipitation, and departures from the normal, show respectively the averages for the several districts. The normal for any district may be found by adding the departure to the current mean when the departure is below the normal, and subtracting when above.

In the middle and southern Rocky Mountain slopes, the south Atlantic and east Gulf states, and in the eastern part of the west Gulf states, the month of January was warmer than the average, but the departures from the normal temperature in the districts named did not exceed 4° and at most stations were less than 2°.

In all other districts the month was colder than the average, and it may be rated as an exceptionally cold one throughout the northern portions of the country. In New England, the upper Mississippi and Missouri valleys, and in the northern and middle plateau districts, the departures from the normal temperatures ranged from 8° to 12°, and these marked departures are shown by comparison with normals of the oldest established stations of the Signal Service. North of the fortieth parallel the deficiencies in the mean temperatures have nowhere been less than 4°, except over portions of the eastern slope and the Lake region and in the upper Ohio valley.

The following are the most marked departures from normal temperatures at Signal Service stations:

Above normal.	°	Below normal.	°
Pensacola, Fla	3.8	Winnemucca, Nev	12.3
Las Animas, Colo	3.6	Helena, Mont	11.7
Montgomery, Ala	3.1	La Crosse, Wis	11.4
Atlanta, Ga	3.0	Davenport, Iowa	11.3
Fort Davis, Tex	3.0	Des Moines, Iowa	11.1
Santa Fé, N. Mex	2.7	Saint Paul, Minn	10.9
Cedar Keys, Fla	2.3	Boisé City, Idaho	10.3
Chattanooga, Tenn	2.1	Dubuque, Iowa	10.0

RANGES OF TEMPERATURE.

The monthly and the greatest and least daily ranges of temperature at Signal Service stations are given in the table of miscellaneous meteorological data, and the extremes below. As usual the ranges were greatest over the region between the Mississippi and the Rocky Mountains. They vary from 75° to 105° in the upper Mississippi and Missouri valleys and in the northern and middle Rocky Mountain districts; the least monthly ranges occur along the Pacific coast, where they generally vary from 30° to 40°.

Greatest.	°	Least.	°
Fort Laramie, Wyo	105.5	Key West, Fla	22.5
Poplar River, Mont	100.8	San Diego, Cal	31.5
North Platte, Nebr	100.8	San Francisco, Cal	34.1
Fort Custer, Mont	99.1	Fort Bowie, Ariz	39.8
Fort Maginnis, Mont	99.0	Los Angeles, Cal	40.1
Denver, Colo	96.3	Tatoosh Island, Wash	41.4
Rapid City, Dak	95.7	Port Angeles, Wash	42.0

The greatest daily range of temperature for the whole country was 66°.5 at Helena, Mont., and the least 1°.8 at Shreveport, La. Daily ranges exceeding 60° occurred at Fort Maginnis, Helena, and Poplar River, Mont., Denver, Colo., and Abilene, Tex.; daily ranges of 3° or less occurred at Albany, N. Y., Leavenworth, Kans., Galveston, Tex., Shreveport, La., Pike's Peak, Colo., and Astoria, Oregon.

LOW TEMPERATURES.

The following notes on the extremely low temperatures of January have been received:

California.—Sacramento: a minimum temperature of 19° was recorded on the 14th; this is the lowest recorded since the establishment of the Signal Service station on July 1, 1877, and it is also the lowest known since January 21, 1854, when a similar temperature was observed by Dr. Logan. Between the 15th and 18th ice on streams, etc., was sufficiently strong to bear the weight of persons, an unusual occurrence for this region.

Georgetown, El Dorado Co.: the minimum temperature on the 14th, 11°, was the lowest ever known to have occurred at this place. Rose bushes that had been set out for the last twenty years and that were never before injured had their foliage completely destroyed.

Fort Bidwell: the lowest temperature ever known at this place occurred between 4 and 6 a. m. on the 14th, when a minimum of —26° was recorded.

San Francisco: a minimum temperature of 29° was recorded on the morning of the 15th, it being 4° lower than any previously observed at this place since the establishment of the Signal Service station in March, 1871. Ice formed to a thickness of four inches.

Willows, Colusa Co.: the night of the 15th was the coldest experienced during the last fourteen years.

Dr. J. B. Trembley, of Oakland, reports: "the weather from the 8d to the 18th was the coldest ever observed by American settlers in California."

Nicolaus, Sutter Co.: the unusually cold weather during the month caused much damage to plants and trees.

Idaho.—Boisé City: the minimum temperature on the 15th, —28°, is the lowest recorded at this place since the establishment of the Signal Service station in 1877; the loss of live stock on account of cold weather is already considerable; the frozen streams deprive the cattle of drinking water.

Iowa.—Mr. J. P. Walton, Muscatine, Muscatine Co., furnishes the following: "My meteorological record reaches back fifty years—to January 1, 1839. January 15, 1888, as a whole, was the coldest on record. Below is given a table showing the five coldest days for the period named: